AQUASTRESS

Mitigation of Water Stress through new Approaches to Integrating Management, Technical, Economic and Institutional Instruments

Integrated Project

D 5.3-1

I. SURVEY ON PAST EXPERIENCES AND PRACTICES ON THE USE OF ROLE-PLAYING GAMES IN THE FIELD OF WATER MANAGEMENT

&

II. PROPOSAL FOR A COMMON FRAMEWORK

Due date:	31-07-05 (M6)
Actual submission date:	*10-1-06*
Start date of project:	1-02-05 Duration: 48 months
Deliverable Lead contractor: (*Organisation name*)	*CIRAD*
Participant(s) (*Partner short names*)	*CIRAD, CEMAGREF*
Author(s) in alphabetic order:	Dionnet Mathieu (CIRAD), Barreteau Olivier (CEMAGREF), Daré William's, Jourdain Damien, Jamin Jean-Yves (CIRAD)
Contact for queries:	Dr. Jamin Jean-Yves, Cirad - UMR G-Eau,TA 60/02 - 34398 Montpellier Cedex 5 Tel (33) (0)4 67 61 58 15 ; Fax (33) (0)4 67 61 59 88 *jamin@cirad.fr*
Dissemination Level (*PUblic, Restricted to other Programmes Participants, REstricted to a group specified by the consortium, COnfidential only for members of the consortium*):	PU
Deliverable Status:	*Revision 1.1*

Abstract

The first part of the present report gives some key ideas on how to better assess the general aim of the WB5.3, which is to test options proposed by the WB3 with Role-Playing Games (RPGs) and simulations with stakeholders and end-users.

Role-Playing Games involve a rich and diverse range of approaches and methods. This report gives a general idea of what RPGs are and in which field of application they are used. It then overviews the different types of RPGs and what specificities they all share. It continues with a synthesis of games used in the field of water management in order to give a general view of past work and point out some general lessons on the use of such tools.

This survey shows that RPGs are relevant tools to deal with social issues involved in water management.

The second part of the report proposes a common framework to develop Role-Playing Games (RPGs) in the AquaStress project.
We assume that RPGs can be used for two purposes that fit into both phases that involve stakeholders: (1) to define which option(s) policy makers, stakeholders and technical experts want to develop and implement, and (2) to test and evaluate the chosen option(s).
This report reviews the design modalities of these RPGs, the way to describe their architecture and dynamic, their analysis frame and the type of evaluation that should be made.
The aim of this framework is to inform the AquaStress partners about the type of RPG we propose to use in the project and for what purpose they will be developed, but also to help the designers of RPGs to make comparisons between RPGs and give them the possibility to reuse the shared characteristics among RPGs.

Contents

I. SURVEY ON PAST EXPERIENCES AND PRACTICES ON THE USE OF ROLE-PLAYING GAMES IN THE FIELD OF WATER MANAGEMENT

1. Introduction

This report has been drawn up as part of the AquaStress project. The overall aim of the AquaStress project is to help the stakeholders involved in water management to mitigate water stress problems. This project is divided into three phases that can roughly be described as (1) the diagnostic, (2) the formulation of options of mitigation and (3) the implementation of these options. This activity is led through seven different "Work Block", which operate as science management units. Because the mitigation of water stress at regional scale depends not just on technological innovations, but involves decision-making process, stakeholders are involved in the process from the beginning of the second phase.

Linked to the Work Block 5.3 (WB5.3) that process with "virtual implementation and validation through group simulations", the present report should give some key ideas on how to better assess the general aim of the WB5.3, which is to test options proposed by the WB3 with Role-Playing Games (RPGs) and simulations with stakeholders and end-users.

Because Role-Playing Games involve a rich and diverse range of approaches and methods, a survey on past experiences and practices on their use in the field of water management has been carried out. The first aim of this report is to give a general idea of what RPGs are and in which field of application they are used. It then overviews the different types of RPGs and what specificities they all share. It continues with a synthesis of games used in the field of water management in order to give a general view of past work and point out some general lessons on the use of such tools.

2. What are Role-Playing Games ?

Role-Playing Games are commonly associated with play activities. Their history is in fact tightly linked to it. For instance, backgammon, go and chess, which are often considered as the antecedent of RPGs, are all play activities. But RPGs are not limited to play purposes. They include many other dimensions resulting from the diversity of their applications. The first contemporary RPGs that include such other dimensions are the "Kriegspiel" (Wargames) developed in the 19th century by a Prussian strategist. Those games were used to simulate battles between armies. A training purpose was thus included in their conception in order to develop strategy of fight. Later on, other types of RPGs were developed in different fields such as sociology, psychology, economy, politics or environmental management. Before discussing the different types of RPGs following from theses fields, and to specify their purposes it is essential to define what they all have in common.

All the RPGs set up human interactions around artefacts and/or staging. Players are put in a virtual situation in which they have to behave following a specific role (their own or another one). As Huizinga (1951) pointed out: a game " *is an activity bound in time and space, which includes imaginary components and the enforcement of some rules, inducing group reactions, and which is partially embedded in real-life rather than beside it. It may not be an absolutely free activity. However, it is an extra-ordinary encounter and must be considered as a specific rendez-vous*".

Practically, participants are denominated as players, as they act in a playing context introduced as such, and their behaviour is more or less imposed by a plan of collective/individual rules. Each RPG is constituted by three elements: the **game** itself, with specific rules applied in an environment which describes the world in which the game takes place; the **organiser** who coordinates the game and brings the players in situation; and the **players** who are the actors of the game. As Muccielli (1983) states, a Role-Playing Game is a performance of a problematic situation involving characters who play a specific role.

A RPG session usually takes place in two parts: the game and the debriefing. The game starts with the explanation of rules by the organisers and goes on with the play itself, which is usually organised in several rounds. A plan of observation (observers or audiovisual equipment) is generally used in order to get information about players, follow the progress of the game but also to keep track of and understand what happens during the game. The second part of the RPG is as much important as the first part, and it consists of a common debriefing about what happened during the game. This time of the RPG session allows players and organisers to come back on the game and discuss about its issues. Individual debriefings can also be organised.

The design features of RPGs are extremely diverse. The users' interface can vary from a simple black board to a sophisticated Internet-Mediated (I-M) support. It can be used with or without computer support. The number of participants can vary from two or three up to forty. The length of the game can stretch from half a day to several weeks for I-M games. Finally, a RPG fits (or not) into a process that can vary according to its usage.

Except for the play games, all other RPGs that are used in many different fields are more or less theoretical. Consequently, the range of purposes for which RPGs are developed is consequently very wide. It can be used for a better understanding of a process or a notion, by the players and/or by the researcher. But it can also be an aid for searching for effective solutions, testing a product, improving a process or coordinating an action between different people. Before exploring the experiences of RPGs specific to water management, and presenting the pros and cons of these tools, we will first review the different types of RPGs that exist.

3. Different types of Role-Playing Game in extensive fields of application

According to the previous definition of what characterises all RPGs, nine classes of games or exercises similar to RPGs have been defined and are presented in Table 1. They cover an extensive range of purposes, have different field applications and have different design features (relation to reality and constraints for players).

Table 1 Characteristics of the different types of Role-Playing Games

Type of RPG	Purpose	Field of application	Relation to reality	Constraint for players
Play games	only a play activity	play activity	totally virtual	fixed rules valid for everyone
Educational games	explain a notion	extensive, from language learning to scientific popularization	generally virtual or very simplified	fixed rules valid for everyone
Dramatised restitution	return knowledge	social work	real situation but out of the context	rules defined by the scenario
Psychodrama and sociodrama	therapy : bring a character or a group to play the tensions that torn him apart	psychotherapy	virtual situation related to past experiences of the patient	rules defined by the therapist, can evolve in the session
Group test marketing and experimental games	test a new product or technical	extensive, from industry to medicine	conceivable situation	weak
Business games	optimize the production of goods	company management	real situation, known by the players	weak, rules can be called into question
Policy simulation exercises	educational and/or training and/or negotiation	management	possible situations	weak, open rules
Experimental social sciences	knowledge acquisition about behaviour	research in economy and psychology	theoretical situation	totally (pre)defined
Common-pool resource management RPGs	knowledge acquisition and help to mediation	renewable resources management	from virtual to real situation	weak, open rules

Play games

Play games or simulation games are unquestionably the most frequents type of role-playing games. Developed since antiquity, these games differ from all other types of games by their basically play purpose. Distance to reality is part of the target, and even if they are often inspired by real world, what happens during the game is not suppose to have any influence after the game. There are different kinds of play games:

- Wargames, where players re-create past battles in various degrees of complexity. They probably are the closer to politic simulation exercises;
- “Board games” such as Dungeons and Dragons which are pretty close to the parlour games except that rules are generally more complicated and can require cooperation between players;
- Role-playing games where players simulate the game out of the board in life-size.

Educational games

Educational games are widely spread nowadays, especially for language teaching. They became popular in the 80’s with the development of the communicative approach in the field of education. They are used in many domains, including water management and are often used with a computerised support (McGrenere, 1996). A

specificity of educational games is that they can be used with children or students as much as with adults for professional purposes.

Dramatised restitution

Theatre produces types of situations that are close to RPGs and they use the same terms such as “play” or “role” to explain the processes. Dramatised restitution is a form of theatre where actors use improvisation to gather together or return acquired knowledge. It is therefore used for educational purpose, but it can also be used for political purpose or as a therapy when the actor plays the passion that tears him like in the “Theatre of the oppressed” that Boal has developed (Boal & McBride, 1985). We can then talk about psychodrama or sociodrama.

Psychodrama and sociodrama

Psychodrama is a therapy that increased in importance in the 40s following methods of social psychology. It is based on the practice of conducted collective games. It aims to make the subject become aware of his real personality and help him to get rid of destructive and repetitive attitudes and roles by playing his own role in front of people. By expanding it to a group, and making him play the tensions that can tear him, one passes to sociodrama. The “play” character of this kind of therapy allows the subject to transcend situations more or less near a difficult reality (Moreno, 1970).

Group test marketing and experimental games

This family of RPGs share a common purpose: the test of a new product or process. Potential customers or users are asked to test it in some presented situation that reproduces real-life situation.

Business games

Business games and policy simulation exercises are two close categories. They both put in situation people who are induced to improve their communication and/or coordination for the purpose of common work. Business games differ from policy simulations in their relation to reality. Business games put people in real and repeated situations whereas political simulations puts them in situations that “could” possibly happen – “what if?” scenarios. In both cases, the people concerned need to reproduce their real role. Business games allow the sharing and testing of new rules or behaviours to improve the running of work groups. They are thus particularly efficient for organisational change (T.C. Schelling, 1961). A synthesis of experiences made on 88 business games shows concrete improvement in dialog and new ways of thinking (Forssén & Haho, 2001).

Policy simulation exercises

Close to wargames, policy simulation exercises (PSE) are widely used to think about the way to manage potential situations in all kind of fields (Duke & Geurts, 2004). For instance, PSE can be used by the army to test its capacity to respond to an attack, or by the staff of a hospital to test a plan in an emergency situation. As Toth pointed out (1988) the principal part of a policy exercise is the development and analysis of scenarios: *“Scenarios provide the framework in which issues from various fields affecting the practical problem on the table are integrated and bounded and in which specific policy options are tested during the interactive phase”*. Because of its virtual dimension and its play atmosphere, PSE is used as a prospecting method, and it improves communication between players. K. Green (2002) found out that: *“role-playing will provide more accurate forecasts than the other methods (game theory and unaided judgement) for forecasting decision in conflicts because it provides more realistic representation”*. It is therefore a particularly good tool to improve the management of a possible problem that have to face different types of stakeholders.

Experimental social sciences

This type of RPG places players in a very controlled situation in order to analyse and understand the collective and individual behaviour that it causes. Experimental social sciences can be used to test a new theory or hypothesis, or as a prospecting tool for a better knowledge of human behaviour (Friedman & Sunder, 1994). It proved to be a relevant tool when examining issues regarding renewable, common-pool resources for which classical economic theory does not generate clear predictions (Cardenas & Ostrom, 2001). Players usually are students, but experiences with professionals or local stakeholders have also been undertaken. To encourage

participation and incite the players to behave as they do in real life (for behaviour relative to economy), players are usually paid according to their game outcome.

Common-pool resource management RPGs

The last type of RPG has been developed by a community of researchers working in the field of renewable resource management (Bousquet, Barreteau *et al.,* 1999). These researchers have developed the Companion Modelling approach that combines the use of computerised models such as MAS[1] and RPGs. On the border of PSE and business games, the Companion Modelling RPGs (CM-RPGs) deal with specific management problems regarding common-pool resources. Globally, CM-RPGs are used for two purposes that can be considered as complementary: (1) to assist mediation on the resource management and (2) to understand stakeholders' behaviour. Some of these games have also been used for training purpose with students, but it has never been an intrinsic task of CM-RPGs. Tightly linked to the use of a MAS, a CM-RPG allows to open the model and ratify its components in order to build a common representation of the system between the different stakeholders. It serves then as a support for discussion and negotiation about possible management solutions. Researchers developing CM-RPGs are aggregated among the "ComMod Charter[2]" that exposes the scientific posture of the modeller in term of ethic and methodology.

[1] Multi Agent System
[2] http://cormas.cirad.fr/en/reseaux/ComMod/charte.htm

4. RPG, a tool used for social learning in the field of natural resources management

The RPGs used in the field of natural resource management are mostly educational games, policy simulation exercises, and companion-modelling RPGs. This section presents some specific features shared by these types of RPGs regarding a global objective that is included in the AquaStress project: improve the Social Learning process.

As Craps (2003) pointed out, Social Learning (SL) is a rather new concept, but nowadays inescapable in the field of public participation. This author refers to it as the growing capacity of a multiple stakeholders' network to develop and perform collective actions. It involves a social and technical participation process, as well as the outcomes of this process. A wide range of Information and Communication tools (IC-tools) are used to facilitate the SL process. They range from spatial representations to simulation models, as well as to stakeholders' platforms or RPGs. A judicious classification and analysis of these different tools can be found in the report of the HarmoniCOP European project (Maurel, 2003). In order to gain a better understanding of the specificities of RPGs compared to other IC-tools, three features of RPGs will be developed: distance to reality, underlying collective processes and long term issues.

Distance to reality

Distance to reality represents the most particular and innovative aspect of RPGs and is its principal difference with other IC-tools. As mentioned before, RPGs are more or less connected to reality. Even for those which represent real contexts (what we can call “contextual” games) a distance spontaneously appears because of the intrinsic nature of the game (Daré, 2005). The game is an activity in which we step out of the reality for several reasons: firstly, because one’s decision does not affect reality (at all or immediately) - the game allows experimentation without risks because it is totally reversible, and it enables the player to get out of his everyday life; secondly, because the environment of the game cannot be a similar copy of the reality and requires a certain degree of abstraction - it demands hindsight and favour the sharing of view points; and finally, because the game is an isolated and specific event during which players experiment with a new situation. For these reasons, RPGs can be considered as relatively free activities that facilitate communication and encourage creativity. They can thus be considered as valuable communication tools to discuss sensitive issues or those usually considered taboo among stakeholders.

Underlying collective processes

Because people have to communicate and behave in a social environment, different kinds of underlying collective processes are associated with the notion of Role-Playing Games. They can be:

- a common goal urging players to interact in order to find a solution;
- a set of common rules and universal constraints which govern the interactions between players;
- a common environment or resource that players have to manage.

The collective process encourages interactions between players, but it also reduces the way those interactions take place. According to the aim of the game, players’ attention can therefore be caught to some specific aspects of the problem. RPGs can in this way be considered as a concrete training tool to share knowledge.

Long term issues

In order to be sustainable, natural resources management needs to consider possible long-term issues. The legacy approach developed by Weber & Bailly (1993) integrates this concern through the construction of long-term goals (what we will donate to our children) between the different vested interest. Once these goals are established, one can talk about the way to reach them in present actions. The distance between the long term and the present days allows participants to escape from the heat of current events and debates, and help them to focus on specific problems (Toth, 1988). It can therefore improve communication between participants. RPGs use a range of time scales that allow dynamics to be examined for even long term or future issues, and provide at the same time a concrete communication support to discuss about these issues, and manage possible solutions. They represent therefore a valuable prospecting tool.

5. RPGs in the field of water management: a review

Many experiences of RPGs dealing with water management have been founded in the literature. The survey is based on the journal Simulation & Gaming, on the Cormas publication database[3], and on searches on the World Wide Web. 30 games were found, and 11 are discussed in this paper. Their description in terms of issues, purpose and outcome is synthesized in Annex 1. Some technical details are also given in this table. These games belong to the different types of RPGs used in natural resource management. We decided however not to present them following strictly this categorisation. Two arguments justify this choice. The first is that RPGs are very flexible tools that can take different shapes and pursue simultaneously different goals, according to their context and history. Therefore the border between the different types of RPG is sometimes very thin. The second argument regards the AquaStress project itself. We wanted to set in parallel the different experiences found in the literature and the possible needs and expectations of the experimental fields of the project (that we assume to be the development of a contextual negotiation tool, that can serve to formalize questions and answers to these questions, and which is at the same time generic enough to be used in different fields). We will thus move on to this section by discussing and analysing specific experiences of RPGs regarding two main criteria that appeared relevant to us:

- their relation to reality;
- their genericity.

The relation of a RPG to reality is analysed thought the environment it recreates. This environment can be virtual (representing a possible, visionary situation), abstract (representing an abstraction of a real situation) or contextual (representing explicitly a real situation). Considering arbitrarily each game built for specific goals and touching a specific public, and confining us to these goals and public, the genericity of a game is understood as its possible use in other situations (fields) that face the same type of issues (that share the same goals). In other words, we do not consider here a generic game as a “multi-purpose” tool but as a “multiple fields sharing the same types of problem” tool.

RPGs as useful training tools

In the field of water management, games have been used as training tools for a long time (Lenselink & Jurriens, 1993). I. D. Carruthers was the first to develop and use such games in this field. In 1981 he created **the River Wadu role-playing game**, an educational game dealing with irrigation planning issues used for post-graduated agricultural economists (Carruthers, 1981). This game was originally designed to give students an experience with a wide range of the practical problems arising in irrigation project planning (Lenselink & Jurriens, 1993). The purpose of the game changed with time, and it was later used in order to stress the multidisciplinary character of the students’ future work and to develop their presentation skills. Carruthers experience is followed by many others during nearly a decade. Globally, these games pursue the same types of goals and they were built in the same mind. Used with students, engineers, or senior managers, these games were mostly addressed to experts or future experts in order to enhance their professional abilities through the learning of a new concept, process or phenomena, or through the improvement of their communications’ modes.

A successful game is the one developed by Burton (1989). **The Irrigation Management Game** was designed with the general aim to demonstrate the interdependence between crop growth, farm localisation within the irrigation system, work performed by staff of the irrigation department and water supply. Initiated in 1982, this game evolves from a simple cardboard game to a professionally produced and marketed package. The game was generic enough to be used in different contexts in different countries and with different publics. For instance, it was played by agricultural economists at the University of New England, Australia, by the irrigation officials in Nigeria or by students in the University of Southampton, UK. This game proved to be a very useful tool for introducing people to a concept at the beginning of training courses or workshops. The outcomes of this game, like in many others, are difficult to assess, and they vary depending to the group and the setting. Nevertheless, Burton (1989) pointed a specific contribution of this game that goes beyond the simple educational purpose. When played by professionals, the game often allowed them to comment on sensitive issues, such as corruption. The author found that following the session, exchanges between players over personal experiences often take place.

Close to the previous game, **the Rehab Irrigation Game** developed by Steehuis, Oaks and al., (1989) was presented as a learning tool for system rehabilitation. Even if some specific structural details of this game were taken from a real Irrigation System in Burkina Faso, it is still a virtual game. Unlike Burton’s game, the Rehab

[3] http://cormas.cirad.fr/

Irrigation Game aims to provide a non-threatening environment in which engineers, social scientists, planners and others can practice developing rehabilitation plans for a hypothetical irrigation system (Steenhuis Oaks and al., 1989). The purpose of this game is to improve the way the different stakeholders approach the creative phase of the design of a system. The participants' feedback shows that this goal is reached as they felt that they gained a design experience that could otherwise only be obtained with real-life irrigation system.

A new set of concepts

After a less fruitful period during the 1990s, the uses of RPGs resumed in the field of water management in the beginning of the 2000s. This new set of RPGs comes within the scope of the putting in practice of new concept such as public participation, process management and social learning (Maurel 2003). Thereby, they slightly differ from the first one. Their purpose is more linked to negotiation processes and collective choices than to the enhancement of professional skills.

The Riparwin River Basin Game developed by Lankford and Sokile (2003) comes close to these purposes. Originally developed as a teaching tool for undergraduate students at the University of East Anglia, UK, the game was then transposed into real-life context and used in Tanzania. Designed to assist water users that share small river catchments, this game differs from all the previous ones on a precise point: sessions have been played with farmers only. Based on a very simple virtual representation of the dynamic of a river (marbles rolling on a leaning board) on which the farmers can intake water (wood sticks) (figure 1.), this game was not only a tool of learning and a support of discussion, it allowed farmers to elicit many suggestions regarding real-life solutions and revealed to them that they held the keys to managing water, rather than relying on external agents and solutions. Its designer point out the fact that this game will probably not find application in larger basins or in sophisticated catchments, but he assumes that it might have applications in the Mediterranean countries where conflicts exist between upstream and downstream users in relatively small catchments utilising surface water. This game is close to the companion-modelling RPGs, which are described bellow.

The MEDTER Game (Le Bars, Le Grusse *et al.,* 2004) has a history similar to the previous one. First designed for a course (figure 2), its methodology was then applied to build a game used in South-West of France with farmers. Closer to a business game than to a teaching game, this game is based on the use of a simulation tool (OLYMPE) developed to assist farm management. In this game, players choose individually their crops in their farm. The impact of these choices in term of water consumption and prices on markets (local and export) is then discussed. Players are then led to a negotiation phase before taking their individual choices. Used as a negotiation tool and as a support for the test of new rules of collective management, this game reproduces an environment that is very close to farmers' reality. Their virtual farm is based on the analysis of farms sharing the same characteristics in real life context. This game can in this way be considered as an abstract game. Farmers can thus recognize their own farm through the game, and the translation of what happens during the game onto reality is easier. Because it uses a generic simulation tool (OLYMPE) that can be applied on different types of farms, the game can easily be translated in other contexts regarding farms' water management. Nevertheless, it really demands a previous work on each specific context in order to build the characteristics of the "stereotypical farms".

The development of computerised models such as MAS

The first companion-modelling RPGs appeared in the same way of the development of the previous RPGs. It comes with the expansion of the use of computerised models such as multi-agent systems, in the field of renewable resources management. It is therefore difficult to discuss CM-RPGs separately from MAS.

The aim of MAS is to understand how independent processes can be coordinated. Used as a modelling tool for common-pool resource management, it allows to simulate the interaction between groups of agents and resource dynamics. Several uses of a MAS related to natural resource management in the companion-modelling approach have been described by Barreteau, Bousquet *et al.,* (2001): MAS are used to simulate ecosystem evolution for (1) research, (2) training and (3) discussion support purposes. MAS allow first to conduct experiments with fully repeatable and controllable scenarios, of reasonable duration and with no potentially harmful consequences for the people living in the ecosystem concerned. MAS provide secondly a tool to explore the consequent of defined rules on the ecosystem, starting out from different initial contexts, and offer thus a better understanding of the complex behaviour of the ecosystem. MAS can thirdly be used as a mediating object to build a common and

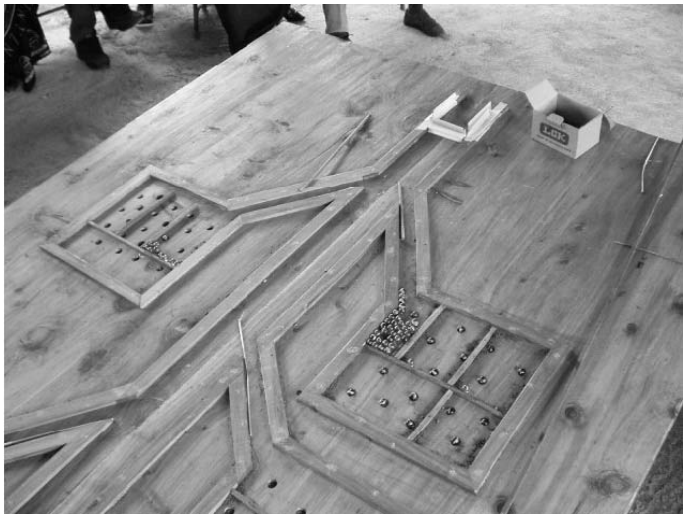

Figure 1 Detail of the top part of the river basin game, showing main channel, abstraction points, intake design, farms and fields, marbles used to depict water and holes in fields to depict irrigation need (Lankford & Sokile, 2003)

Figure 2 Negotiation phase during the MEDTER game (Le Bars, Le Grusse *et al.,* 2004)

Figure 3 Self Cormas experience. Hot debates from RPG then MAS, even with people lacks of formal education (D'Aquino, Le Page *et al.,* 2003)

shared representation of the system in order to support group decision through better negotiation. More information about MAS can be found on the Cormas Web site[4].

O. Barreteau (2003) characterised the joint use of RPG and MAS regarding negotiation process as a mutual support process. RPGs introduce uncertainty and complexity in the system by involving the various viewpoints while computerised models considerably ease their use and design. Practically, the MAS serves first as an interface between the players and the underlying ecosystem dynamic, it allows next to speed up the time of the game to explore long term issues by reproducing what happens during the game or by exploring new sets of rules. The consequences on the field can be the modification of (1) the stakeholders' perception, (2) the way they interact, and (3) the actions they undertake. The design of a MAS can come before, during or after the RPG session, but it is however not an indispensable task of the companion-modelling approach. In fact, other types of models can be used. Several RPGs regarding water management have been developed with the companion-modelling approach.

The Njoobaari Ilnoowo game (Barreteau, Bousquet et al, 2001) is the first operation conducted under the companion modelling approach. The game was dealing with the question of the viability of an irrigated scheme in Senegal, and it was based on a previously built MAS. Its initial objective was to explore whether this viability was in relation to the coordination modes between farmers, and if so, the way the coordination could be improved. Because of practical and ethical reasons, the game was designed on a virtual irrigated system typical of the central Senegal River valley, but which did not represent any particular scheme. In this way its relation to reality is close to the MEDTER game and it belongs to the abstract game class. In Senegal, players learned about their collective behaviour in the system and researchers improved their comprehension of the common social background and the way it affects players' behaviour, what Muchielli (1983) calls the "social roles". This game was also played with students in France, South Africa, Thailand and the Philippines. The purpose is however completely different. In one case the game is used as a discussion support in real-life context and as an investigation tool for researchers, in the other case, it is used as a teaching tool to present the complexity of managing a common pool resource.

A recurrent topic in the CM-RPGs is that of water rights. It involves more organisational issues than technical ones, and consequently refers to social sciences' concepts such as social justice. **The Just Game** developed by Ferrand, Nancarrow *et al.,* (2005) is based on past survey about principles for fair allocation of water expressed by a small population of Australian farmers. It first aims to improve researchers' knowledge about social justice, and secondly (eventually), it aims to promote different management protocols. In this game, players have to manage their farm and cope with water stresses, which follow from their individual actions. But unlike other games, justice principles are explicitly presented to players that have to deal with them. The expected output is to specify management schemes that are compatible with the preferred justice principle by communities. The game is coupled with different models (farm, water dynamic, market) that players can either totally (RPG) or partially (simulation mode) control. Farms characteristics, water system dynamic and socio-economic context are representative from a specific river basin perimeter, but this environment is still an abstraction of the reality.

Regarding the question of time scale in water management, a particular example should be detailed. **The Pieplue game** was designed by Abrami, Barreteau *et al.,* (2005) in order to provide an interactive setting for future possible revision of a SAGE (Local Water Management Plan) in the Drôme River Valley in France. Players randomly receive virtual fields that they have to manage over three time scales:

- a short time scale (a day) during which the farmer has to choose the plot to irrigate, and that is simulated by an agent based model;
- a medium time scale (a month) during which the farmer has to manage his different crops by developing irrigation patterns;
- a long time scale (a year) during which the farmer has to choose a cropping pattern and to discuss on collective rules to share water.

Players also receive objectives to help them taking up their role. The authors found that the complementary use of gaming and simulation allowed both to generate discussion through interactive and gaming atmosphere, and to tackle scenarios through the computer simulation part. This game is abstract but not thoroughly generic. Several difficulties appeared when the game was played with managers that were not completely familiar with the specific irrigation issues of the game. Finally, because of a political locking, this game has never been played by farmers.

[4] http://cormas.cirad.fr/en/demarch/sma.htm

Developed for the support of a decentralization local politic, in northern Senegal, **the SelfCormas game** is a successful experience of a common built representation process (D'Aquino, Le Page *et al.,* 2003). The global objective was to help local rural communities to manage their land in a sustainable way taking in consideration its different uses, notably agriculture and cattle farming that were in conflict regarding access to water. In this experience, the MAS objective and rules were commonly built with researchers and farmers during the RPG sessions, coming to a shared representation of the system. The RPG served as a dialog interface between computerised modelling and the stakeholders (figure 3). Simulations served to explore different scenarios, and allowed stakeholders to agree on new collective rules. For the authors, in this experience, the model does not aim to provide solutions to the problems, but to favour discussion over different alternatives, to improve the collective decision process and even to modify the behaviour of local stakeholders towards their technical partners. The technical evaluation is here the next step, not the previous one.

Games for policy simulation exercises

Following the emergence of new political concerns, such as participative democracy, at the end of the 90s, policy simulation exercises start to be used on water management issues. Many of these games are connected with large-scale water management policies concerns, such as the Nile management policy in Egypt (Hermans & Bots, 2002), the global water management policy in the Netherlands (Carton & Karsten 2002), or the water management policy of a big city as Zürich (Hare, Gilbert *et al.,* 2001), but they are not restricted to this field. These games are still and all mostly intended for policymakers and scientists, but some of them are also suitable for interested non-professional parties and are in this way close to educational games. To illustrate the outcomes of these games, two examples will be developed in the next subsection. One refers to water management in the Netherlands regarding spatial organisation, the other to the water supply management policy in Zurich regarding stakeholders' conflicting goals.

In Netherlands, water management is a constant and important preoccupation for researchers and politicians, and these are looking for the opportunities to make it more sustainable and more robust. **The Water for Space game (W4S)** (Carton, Karstens *et al.,* 2002) arose from this context, and its major goal was to enable the players to visually experience the space that water can provide in the Netherlands. But it was also built to improve communication between spatial planners and water administrators, and to illustrate how social and economic uncertainties affect the way space and water are organised. W4S game is based on a map board that represents Netherlands and is thus spatially close to the reality. The players' task is to organise the spatial design of the entire Netherlands, which oversteps however most of their real professional responsibility domain. Thus, one can consider this policy exercise as virtual and generic, even if it was applied in the specific Netherlands context with spatial planners. The authors observed that each time the game was played, discussions were hold about future developments in water managements forcing the players to share their underlying viewpoints. Even if it improved dialog between stakeholders, the authors felt that the design of the game was more instructive than actually playing the game, because it led to a better understanding of the complexity of the interdependencies between spatial planning and water management. The game represented thus a very good tool to improve the way to arrive at a common vision, rather than actually find the vision itself.

The FIRMA Watergame was originally designed by Hare, Gilbert *et al.,* (2001) in order to support the emergence of new way of managing the water supplying system in Zurich. It relies on a dilemma regarding stakeholders' conflicting goals of maintaining water security and quality, saving money and saving water. As Hare, Gilbert *et al.,* (2001) describe: "*The goals of this participatory process include the exploration of more efficient management strategies in response to possible demand scenarios and to increase communication and the sharing of perspectives among various stakeholders*". The game itself represents the last stage of the participatory process. Its specificity consists in using an Internet forum in order to create an interactive multi-player computer game. This Internet-mediated (I-M) game showed several advantages (Asakawa & Gilbert, 2003) such as allowing a long playing time (2 weeks) and the undertaking of the players' anonymity in their actions, but it revealed that human facilitator were indispensable, and face to face debriefing necessary for a better use of the outcomes of the game. In fact, like all other RPGs, I-M games used for politic simulation exercises still need to confront, at times, the different stakeholders in order to improve their communication.

6. Lessons over a 25 years experience on the use of RPG on the field of water management

Finding the harmony between play and reality

A RPG recreates an environment that is the basis of all possible interactions that can occur during the play session. As we saw for RPGs developed in the field of water management, this environment can be totally virtual, abstract or contextual, built by the game designer only, or both by the designer and participants. Dealing with this environment depends on the goals of the RPG, and is specific for each context. However its formulation often faces two contradictory concerns (Toth, 1988):

- It should allow participants to get out of their usual scheme, remove them from their daily life in order to consider other points of view; but at the same time
- It should preserve some basic features of real life in order to give the game sense and make it useful.

Finding the harmony between these two concerns depends on the purpose of the game (teaching, training, coordination, negotiation, etc.), and one can not assume initially which formula is the best. This task is even more difficult when dealing with socially sensitive issues, such as those encountered by Barreteau, Bousquet *et al.,* (2001) in the Njoobaari Ilnoowo game (castes and existence of land-keeping objectives among farmers). Because there was absolute refusal to take them into account as a reality in relation to irrigation systems, the authors used archetypal representations of social relations (hierarchy, equivalence networks) instead of the particular ones. They used them as examples in order to explain what they represented. Smith (1989) was also confronted to such sensitive issues. In his case, they were a consequence of playing the game, not a problem the game had to deal with: *"Games (...) can also mimic more sensitive issues, for example corruption or nepotism"* (Smith, 1989). One can thus consider abstraction as a useful feature that could allow the breaching and discussion of sensitive issues. Based on a virtual or abstract environment, what is learnt from these RPGs is however more difficult to be translated into or compared with real-life experiences.

The acceptability of the RPGs

Understood as the empowering of the local communities and as the improving of democracy, public participation aims over-al to allow people to influence the outcome of plans and working processes. We saw that among the different approaches and uses of RPG, some explicitly aim to provide a support to develop such purposes. Agreeing on the fact that the public has to express his expectancy, and that specific tools such as RPGs are available, one can think that a sufficient number of features are present for the public to participate. Unfortunately, experiences have shown that the public participation is not always effective. For instance, some RPGs developed with the Companion Modelling approach were confronted with political locking and the process had to be stopped (Abrami, Barreteau *et al.,* 2005; Perez, Dray *et al.,* 2003). One should thus closely consider the acceptability of the RPG, and try to assess why the public effectively accepts or not to take part of (1) the global process in which the RPG takes place and (2) the RPG session itself.

The acceptability of the RPG approach has first to be addressed towards its usage in a global process including the recourse of the expertise (that propose specific solutions). The ComMod approach assumes that the expertise should best follow the expectancy of the stakeholders. The RPG is used to accompany the process which is "leaded" by the stakeholders. Following a RPG session, specific expertise can be carry out on the chosen issues. In this case, the participation of the public is facilitated because stakeholders are involved from the beginning of the process and have the means to influence it in its wholeness. On the opposite, in many cases, the expertise comes before its presentation to local stakeholders. In this case, stakeholders do not easily accept to participate as they were not those who explicitly demanded such expertise, but at the same time, this approach allows researchers to address crucial issues that are not of-the-moment concern of the stakeholders.

The acceptability of the RPG approach has then to be addressed towards the usage of the RPG itself. Several reasons regarding the participant could explain why a stakeholder can individually be motivated to participate to a RPG session: to defend his own interest; because of his own curiosity or interest; because he earns some compensation; etc. However, some intrinsic features of RPGs actually help the public to participate. First, as said before, a RPG is a free activity, and one can consider that having the liberty to come or not to a RPG session is itself the first requirement needed for public participation. Then, a RPG is an "active" event, and once the participant enters in the process, he "acts" and has to pay attention to what happens around him. Furthermore, if he is not used to express himself in public, it is easier for him to do so through acting during the RPG than in classical meetings that always favours the best talker. Finally, once he starts "playing" with the other participants, a common motivation spontaneously appears because of the dynamic of the RPG. Consequently, a RPG can itself reveal the interest for the participant to discuss together about shared issues, that is to say to participate.

The commitments of RPGs design

The design of a RPG can pursue a wide range of purposes and its commitments vary consequently. Focusing on the improvement of collective decision processes, we previously saw that it is essential to consider the acceptability of the approach. Actually, building a RPG in a situation where the power struggle is implicit and which is prone to go to a global enhancement of the conflict is hazardous. A good understanding of the local context is thus necessary. It can for instance be undertaken through a stakeholder analysis that identifies the key stakeholders, assesses their interests and the ways in which those interests could affect the usage of the RPGs. Such analysis should help to consider the acceptability of the approach, but it should also help to consider other aspects such as the relation to power, the technical capacity to participation or the link between the basis and its representatives. This first step is essential to design a RPG that fits into a carefully considered process.

Once the purpose of the RPG is defined, and its place in a process considered, M. Etienne (2005) stresses different aspects of its design and play that need to be closely considered. The designer has:

- to choose the relevant information;
- to establish the rules for each action of the RPG;
- to choose the degree of realism;
- to calibrate the model of the RPG;
- to determine the RPG's forms (to choose the type, role and number of players, to choose the time step, to organise the space, to represent spatially the territory, to make explicit the available information, to choose the forms of safeguard of each played game);
- to animate the RPG (to invite the participants, to explain rules, to assign the roles, to spread the available information, to make sure the game goes well, to memorise what happens during the game);
- to analyse the game just after the play with the participants (on the quantitative results, the decisions taken, the negotiation phases, the spatial consequences) or after the game (on the behaviour of the participants, to compare different sessions);
- to evaluate and validate the RPG.

Closely weighting up these steps will help the designer of the game to determine the means he has to call up in terms of technical competences and material and time costs. In all cases, designing a RPG usually takes more time (months) than playing the game (days). Ethical concerns should also be considered, such as the responsibility of the designer (is the discussion during the game going to provoke conflicts?) or the rights of the approach (is someone using the game to defend his interest?). Thereby, designing a RPG is not a simple task, and specific training courses can be taken such as those given by the ComMod school[5].

About some specific outcomes

The contributions of RPGs in the field of water management have to be considered on the light of the multiplicity of the experiences that have been carried out. We can distinguish who benefits from them. It can either be the participants or the organisers.

Regarding the organisers (that are not necessary researchers), the design of the game itself can improve their knowledge about a complex situation (Carton, Karstens *et al.,* 2002). The RPG session can next be used in order to clarify and to lay down common knowledge. The performing of the RPG can also be used to improve the understanding of the complexity of psychological, economical and political processes (Daré, 2005; Barreteau, 2003; Friedman & Sunder, 1994). For Mayer & De Jong (2004), a RPG provides an experimental environment through which researchers can learn about the system from the interaction between the participants and the model or among participants. Because water management often involves complex socio-politic issues, the use of RPGs as an investigation tool is totally justified.

Regarding the participants, the outcomes of RPGs are much more wide-ranging. Providing a good mean for illustrating complex inter-relationships they proved to be very positive teaching tools for adults and showed that they could help team members to improve their coordination (Smith, 1989; Steenhuis, Oaks *et al.,* 1989; Mayer & De Jong, 2004). RPGs also act as enabler that allows organisations to reform their interpretative framework (Tsuchiya, 1998), and are thus a valuable tool for organisational change. M. A. Burton (1989) found that his Irrigation Management Game stimulated full and frank discussions that enabled participants to identify common

[5] http://cormas.cirad.fr/en/formati/formati.htm

problem areas and possible solutions. In conflicting situations, the use of RPGs can improve discussion and negotiation between the stakeholders (D'Aquino, Le Page *et al.,* 2003; Barreteau, Bousquet et al, 2001; Barnaud, Trebuil *et al.,* 2005; Lankford & Sokile, 2003). To understand more precisely how RPGs reach such global and general outcomes one should consider a more special and unique contribution of this tool.

Mayer & De Jong (2004) experienced that RPGs were relevant for dealing with complex multi-actor or inter-organisational problems. In these contexts, discussion, negotiation process and decision-making face the complexity of the relations and interaction modes between stakeholders. It is precisely for this task that RPGs can have an essential and unique contribution. In a paper dealing with the combining use of GDSS[6] and gaming Mayer & De Jong (2004) argued that in contrast to GDSS which have *"rational-analytical focus"*, games allow *"a more experiential exploration of decision making problem"*. They stressed that games were more effective than GDSS in *"disclosing the unravelled world of implicit motivations, hidden agendas and political wheeling that is characteristic of complex decision-making in multi-actors situations"*. In other words, RPGs provide a relevant tool to bring to light a set of hidden preferences or psychological features that influence our behaviour. The analysis of Tsuchiya (1998) strengthens this idea as it shows that RPGs allow participants to go beyond their restrictive interpretative frameworks. As Mucchielli (1983) explains, the first purpose of a RPG is to bring the participants to become aware of their roles (behaviour patterns), it allows them next to acquire new roles or interaction modes that they did not possess before, and finally it permits them to operate what was previously discovered.

The effectivity of RPGs outcomes

The putting into practice of what is experienced or learnt during a RPG is the last stage of any process that use RPGs for social learning. However, this stage is the less documented and we are inclined to believe that there is a real lack of evaluation regarding to the practical field outcomes of RPGs. This can be due to the "per project" mechanism of most of the organisations, which imposes time-constraints that do not allow the monitoring of the fields over a long period. It can also be due to the "multiple" nature of the previously mentioned outcomes that is difficult to assess from a single point of view. Finally, it can be due to the multiplicity and the interdependence of the external factors that influence the situation. Research has withal started on this problematic, and frameworks of evaluation have already been discussed (Daré, 2005; Mayer & De Jong, 2004; Leeuwis, 2004; Von Paassen, 2004).

Nevertheless, some experiences using RPGs led to concrete results that are easy to discuss. We will thus developed two of them in this subsection in order to give some idea of how the previously enumerated outcomes are translated into practical field outcomes.

The first example is the RPG designed by Lankford & Sokile (2003). B. Lankford measures the outcomes of his RPG as follows:

- farmers/users agree new bye-laws for managing water resources;
- farmers/users agree new institutions for managing water (river user organisation or apex bodies);
- farmers/users seek to have the game played again for other users and themselves to continue down the road;
- farmers/users seek new agreements from basin authorities as a result of playing the game (despite whether or not the latter can reply).

The outcomes "on the field" regard thus both the social organisation of the community (a new institution is created), and the rules that regulates the interactions between the components of the society (research of fairness for the access of the resource).

The **Dompola game** designed by Gurung, Bousquet *et al.,* (2004) reached similar results. It was designed in a conflicting situation regarding water sharing in small villages in Bhutan (annexe1). After several RPG sessions with the farmers from two villages, the participants expressed several desires. They proposed to play the RPG with the farmers from the 5 other villages included in their watershed, to integrate local organizations to the process, and to discuss about the question of the water intake date of the different villages. But the most relevant and effective outcome of the RPG was undeniably the creation of a watershed committee in which the question of the date will be discussed. Thus, the RPG permitted local stakeholder to agree on the creation of a water management structure in order to settle the sensitive issue of the water intake date.

[6] Group Decision Support Systems

7. Conclusion

For M. Janssen, H. Goosen *et al.,* (2005): *"Water management problems are no longer predominantly addressed as technical issues; they have become part of a complex policy process in which many different stakeholders and institutions are involved"*. Our survey showed that RPGs are relevant tools to deal with such social issues. But one should not consider singly the technical and the social issues. The participation of the stakeholders is expected and required *as well as* the technical expertise. RPGs can be used to support stakeholders to express their needs and expectancy *as well as* they can be used as a virtual laboratory to test and (maybe) diffuse expert advice such as technical or organisational innovations. We thus assume that RPGs can possibly be used to make a bond between experts and stakeholders, and this idea we be developed through a next paper that will propose a common framework to design RPG in the AquaStress project.

However, to develop this framework, some crucial information is needed. First, the problematic of the different study fields should be clearly exposed. Then, the goals pursued in each field should be closely considered in order to delineate the common features. Finally, once this information gathered, it will be possible to determinate (1) if there is a real need or demand for the use of RPG and (2) if there is a shared issue on which it could be possible to develop a generic RPG.

II. PROPOSAL FOR A COMMON FRAMEWORK

1. Introduction

The overall aim of AquaStress is to find effective ways to combine the wide variety of existing and new analysis and mitigation options to deliver optimal, adaptable, integrated solutions to water stress. The AquaStress project is divided into three phases that can roughly be described as the diagnostic, the formulation of mitigation options, and the test and evaluation of the chosen option(s). Stakeholders are involved in the process from the beginning of the second phase. Regarding this process, we assume that RPGs can be used for two purposes that fit into both phases that involve stakeholders: (1) in order to support the definition of option(s) policy makers, stakeholders and technical experts want to develop and implement, and (2) in order to test and evaluate the chosen option(s).

In the first case, RPGs are used to support the **definition of sustainable options** regarding the issues that have been identified in the first phase of the AquaStress project, in a participative way. It allows to better assess the pros and cons of the options in terms of technical feasibility, social acceptability and adaptability (sustainability). It should help the participants to define what form the chosen options will take, to prepare them for the next steps of the process, or to develop alternative options which have not been mentioned before (if any new and relevant elements appears during the RPG). Consequently, this type of RPG carries out a social learning process. It is used as a decision support tool, as well as an investigation/diagnostic tool.

Once an option is defined, RPGs can then be used to **test and evaluate** it in a virtual way. In this case, the RPG supports the different steps of the implementation itself. By exploring specific scenarios, the stakeholders will experiment the monitoring of the option under a wild range of conditions. Depending to the chosen option, the RPGs can come to concrete field outcomes as technical and/or organisational changes, as well as they can permit the reorientation of the previous choices.

We assume that these two purposes can be supported by the same type of RPGs that should be flexible enough to take different shapes, depending on the contexts and the goals. The chosen methodological framework on which we will rely to follow through our proposition is the ComMod approach, which, we assume, fits the best our objectives. However, considering the specificity of the AquaStress project, this framework needs to be reconsidered regarding the design modalities, the description form, the analysis and the evaluation of the RPGs.

2. Design modalities

The previous steps

The first step of the AquaStress project (stakeholder analysis) precedes the design of the proposed RPGs. Its methodological framework is not considered in this paper, but, as we stressed in our survey on past experiences and practices on the use of RPG in the field of water management[7], this step is an essential task in order to (1) collect data, understand local context and identify the relevant stakeholders, (2) identify the issues and the formulated needs, and finally (3) engage a participative process to identify possible solutions. Before starting to design a RPG, one should thus consider the entire process in which it will fit and If the conditions are fulfilled to continue.

A generic tool

The design of the RPG has chiefly to be thought of as the expectancy to develop a generic tool. A RPG developed in a specific field of the AquaStress project has to serve the other fields. As stressed previously, we understand the genericity of a RPG as its possible use in other situations (fields) that face the same type of issues (that share the same goals). That said, in order to be consistent, a RPG has to deal with the specificities of each field, and it has therefore to contain specific characteristics. Consequently, each RPG should be unique. Our challenge is to make useful the work carried out for the development of a first RPG for the design of others. The common framework we propose serves this purpose. It should help the designer of a new RPG to refer to or use part of previously developed RPGs to develop his own. Consequently, the design modalities should be the same for all RPGs. Those we propose are inspired by the different experiences found in the literature, notably those developed under the ComMod approach, by Lankford & Sokile (2003) or Le Bars, Le Grusse, et al., (2004).

A participative process

The design of the RPG has also to be thought regarding the desire of public participation. In fact, we propose that the stakeholders actually participate to the design itself of the participation process. Thus, the RPG is co-designed. This necessitates first to build a **shared representation** of the problem between policy makers, technical experts and stakeholders communities. This step is carried through a workshop that is either included in the stakeholder analysis (first phase of the AquaStress project) or either organized as the first step of the design of the RPG (second phase). This shared representation is crucial, and the design of the RPG is based on it. Once this representation is gained, the definition of a global **common objective** on which the game will rely should be assessed. This objective has to reach the overall objective of the AquaStress project, which is the mitigation of water scarcity. It will be defined in common with the stakeholders. At the same time, the possible **options** proposed by either policy makers, technical experts or stakeholders' communities have to be exposed. Once these 3 steps (shared representation, common objective and options) have been carried out, the design of the RPG can start. Participants do not actually participate to all steps of the design, they are only requested to validate the key characteristics of the game.

Some general advises

Regarding the different steps stressed by M. Etienne (2005) the following global design modalities are given:

- The relevant information on which RPG is developed has to be linked to the overall objective of the AquaStress project and need at the same time to support the chosen local options;
- The degree of realism has to be weak and the environment simple and abstract enough to allow the reuse of the first RPG architecture for other fields, but at the same time it has to provide the possibility for the stakeholders to make the link with their reality;
- The rules for each action of the RPG have to be flexible considering the environmental dynamics and the socio-economic factors of the system;
- The calibration of the model of the RPG has to be proportional (only the proportions and the order of magnitude are kept) but should allow to introduce real values to test specific options;
- The RPG form should follow a common frame (cf. bellow) that should be flexible enough to allow the design of RPGs in different contexts;
- The RPG has to be headed by a chosen local mediator who will animate the game, and attended by observers (e.g. local students) who will gather the information and help the participants individually. The

[7] http://innoapre.net/deliverable.aspx?id=66

invitation of the stakeholders has to be individually led, and the RPG will be presented as a collective simulation work;

- The analysis of the RPG with the participants or afterwards individually will follow the pursued goals of the process, half the time of the RPG session should be dedicated to it.

3. A common frame for the RPG's description

The RPGs developed with the proposed framework should follow the global design modalities previously mentioned. But because each field is linked to a specific context, we can assume that each RPG will also have his specificities. Thereby, a common frame should be used to describe the architecture and the dynamic of each RPG. It will allow to make comparisons between RPGs, but it will give most of all the possibility to reuse the shared characteristics among them. This frame consists on the definition and the analyse of the following points:

Parameters of the RPG

1) Architecture parameters of the RPG that are fixed and shared by all players:

- List of the components of the RPG
  - People (which roles are played, which stakeholder are represented?)
  - Environment (which geographical area?)
  - Objects (e.g. water, irrigation scheme, farms, crops, cattle, roads, etc.)
  - Others (e.g. market, administrations, etc.)
- Representation of these components
  - Typology and representation for the stakeholders
  - Space unit and degree of realism for the environment
  - Typology for the farms and the crops
  - Market, etc.
- Characterisation of these components in terms of
  - Attributes (what characteristics are needed to describe this component and which value it takes?)
  - Actions (what actions are supported by this component?)
  - Relations (what relation this component has with other component, what rules exists?)

2) Instance fixed parameter specific to each player

- Definition of the individual value of the players' characteristics
  - Public characteristics (e.g. the cultivation area)
  - Private characteristics (e.g. the farm saving capital)

3) Changing parameters depending on the participants' choices (changes along the game)

- Definition of the benefits of each player (private)
- Definition of the quantity of water allocated (public)
- Etc.

Dynamic model and associated indicators

A specific dynamic model should be chosen to reproduce the dynamic of the previous parameters (environment, economy, etc.). It should be simple, easy to use. Its choice should be discussed with the participants. Associated indicators should be defined, as well as the way to measure them and the type of information (public or private) they will give.

Proceeding of a time step

The proceeding of a time step regards the important decisions taken during a year. It can be described through a sequence diagram (UML) that details each action, who conducts it, with whom and when.

Initialisation

The initialisation of the system defines the initial state of the RPG. Chosen values have to be proportional.

Organisation of the RPG sessions

- Planning program
- Choice of the participants, the moderator and the observers

- The number of player
- Choice of the length of the RPG session + debriefing
- Choice on the spatial organisation of the RPG (public – private space)

Material

- Board or mock Up
- Cards, sheets, manuals
- Software and hardware
- Etc.

Observation mode

The recording of what happen during the RPG has to be thought regarding the relevant information on which it is important to come back during the debriefing. The safeguard form is are sheets on which the principal decisions taken each time step as well as the interactions between the participants. This task is assigned to the observers and is individual (each player is observed at each time step).

4. Analysis

The analysis of the RPG should be conducted on any element that happens during the RPG or that is linked to its usage. It should help, at all level of the process, to define, clarify and give a signification to these elements. The aim is not to give a judgment, but a meaning. The obtained information will be crucial for the evaluation phase. The analysis can be led on two complementary levels.

The analysis of the RPG session

The first level regards the understanding of the RPG session itself. It consists of different phases of analysis:

- Analysis “on-the-spot” just after the game during the collective debriefing
  - What relevant event happened during the game?
  - Which explanation do we have for that event?
  - What option did we choose and why?
  - Etc.
- Analysis “coldly” after a few days during individual debriefings
  - What did this experience brought to me?
  - How do I explain what happened?
- Analysis “coldly” by the designer of the game (cf. evaluation)

The analysis of the subsequent results

The second level regards the AquaStress project. This analysis should define which decisions and/or actions follow from the usage of the RPG, how and why. Considering the RPG as part of a global process, this analysis should also focus on how these elements are linked to the other phases of the project. In other words, it should characterise the links between the RPG and the concrete field outcomes.

5. Evaluation

The design of an evaluation framework is essential and should be closely considered. Globally, one can differentiate (1) the evaluation of the RPGs as a process, and (2) the evaluation of the outcomes of this process.

The evaluation of the process

The evaluation of the process (1) should first focus on its **operationality**. Specific indicators should be used in order to measure the financial and time cost as much as the functionality of the process (its usage in different contexts). These indicators should bring quantitative information about the means to carry out and the cost of their utilisation, but also qualitative information about the usage itself (e.g. difficulties encountered).

On the other hand, it is essential to analyse the **performance** of the process. From an initial state, the benefits linked to the process should be appraised. This step stresses the necessity of the foremost analysis of the local context. For the first type of RPGs, the benefits can refer to the better understanding of the issues and the definition of the options, and for the second type of RPGs it can refer to the improvement of its implementation.

The evaluation of the outcomes of this process

The evaluation of the outcomes of this process (2) should focus on all levels on which the process is assumed to interact. It should appraised how this process has improved the different steps and fulfil the objectives of the AquaStress project, as:

- the definition of a knowledge base, individually then collectively;
- the building of a common representation of the environment and its issues;
- the definition of possible options;
- the choice of one of them;
- the test and the evaluation of this options;
- the global outcomes and returns in terms of taken decisions (e.g. effective technical and/or organisational innovations, or reorientation of the project, etc.) and agreements.

This evaluation can refer to the degree of “awaking” on such issue, the changes of practices or strategies, the social reorganisation or the development of new way of management. But it can also refer to quantitative field outcomes such as the increasing of the production or the drop of the scarcity of water, etc. This evaluation can finally refer to the improvement of the communication among and between the policy makers, technical experts or stakeholders’ communities.

References

included references from annexe I.

Abrami, G., O. Barreteau, *et al.* (2005). Apports des rôles à la construction et à l'expérimentation de modèles multi-agents pour la gestion de ressources renouvelables. CABM-HEMA-SMAGET, Bourg St-Maurice, France.

Adamatti, D. F., J. S. Sichman, *et al.* (2005). JogoMan: A Prototype Using Multi-Agent-Based Simulation and Role-Playing Games in Water Management. CABM-HEMA-SMAGET, Bourg St Maurice, France.

Asakawa, T. and N. Gilbert (2003). "Synthesizing experiences: Lessons to be learned from Internet-mediated simulation games." Simulation & Gaming 34(1): 10-22.

Barnaud, C., G. Trébuil, *et al.* (2005). Evolution institutionnelle de la gestion des ressources renouvelables dans le nord de la Thaïlande montagnard : apport de la modélisation d'accompagnement. Journées de la Société Française d'Economie Rurale (SFER) sur "Les institutions du développement durable des agricultures du Sud", Montpellier, France.

Barreteau, O., F. Bousquet, *et al.* (2001). "Role-playing games for opening the black box of multi-agent systems: method and lessons of its application to Senegal River Valley irrigated systems." Journal of Artificial Societies and Social Simulation [online] 4(2): \url{http://jasss.soc.surrey.ac.uk/4/2/5.html}.

Barreteau, O. (2003). "The joint use of role-playing games and models regarding negotiation processes: characterization of association." Jasss: http://jasss:soc:surrey:ac:uk/6/2/3.html.

Boal, A. and C. McBride (1985). Theatre Communications Group. Theatre of the oppressed. New York.

Bousquet, F., O. Barreteau, *et al.* (1999). An environnemental modelling approach : the use of multi-agent simulations. Advances in environmental modelling. F. Blasco and A. Weill, Elsevier: 113-122.

Burton, M. A. (1989). "Experiences with Irrigation Management Game." Irrigation & Drainage Systems 3: 271-228.

Cardinas, J.-C. and E. Ostrom (2004). What Do People Bring into the Game? How Information Helps to Reduce the Tragedy of the Commons. Washington, D.C., International Food Policy Research Institute: 40.

Carruthers, I. D. (1981). A role-playing game for training river basin planning. River basin planning: theory and practice. S. K. Saha and C. J. Barrow. Wiley: 265-283.

Carton, L., S. Karstens, *et al.* (2002). The W4S game: exploring the future consequences of water management. Games in a world of infrastructures. Simulation-games for research, learning and intervention. I. Mayer and W. Veeneman. Delft / The Hague, Eburon Academic Publishers: 85-103.

Craps, M. (2003). Social Learning in River Basin Management. Leuven, K.U.Leuven - Centre for Organizational and Personnel Psychology: 70.

D'Aquino, P., C. Le Page, *et al.* (2003). "Using self-designed role-playing games and a multi-agent system to empower a local decision-making process for land use management: The SelfCormas experiment in Senegal." Journal of Artificial Societies and Social Simulation [online] 6(3).

Daré, W. and O. Barreteau (2003). "A role-playing game in the irrigated system negotiation: between play and reality." Journal of Artificial Societies and Social Simulation [online] 6(3).

Daré, W. (2005). Comportements des acteurs dans le jeu et dans la réalité : indépendance ou correspondance? Analyse sociologique de l'utilisation de jeux de rôles en aide à la concertation. Sciences de l'Environnement. Paris, Ecole Nationale du Génie Rural, des Eaux et Forêts: 383.

Duke, R. D. and J. L. A. Geurts (2004). Policy Games for Strategic Management. Amsterdam.

Etienne, M. (2005). Jeux de rôles et modélisation d'accompagnement, les étapes de la conception. Montpellier, INRA Unité d'Ecodéveloppement.

Farolfi, S. and K. Rowntree (2005). Accompanying Local Stakeholders in Negotiation Processes Related to Water Allocation Through Simulation Models and Role-Playing Games: an Experience from South Africa. End-user ownership and involvement in Integrated Water Resource Management, Cairo, Egypt.

Ferrand, N., B. Nancarrow, *et al.* (2005). Simulation and role-playing games for social justice research. CABM-HEMA-SMAGET, Bourg St-Maurice, France.

Forssén, M. and P. Haho (2001). "Participative development and training for business processes in industry: review of 88 simulation games." International Journal of Technology management 22(1/2/3): 233-262.

Frank, A. I. and R. D. Duke (1995). SEIDL - Ecosystem Philosophy Game - A Generic-Specific Game. Ann Arbor, MI, USA, College of Architecture and Urban Planning, University of Michigan.

Friedman, D. and S. Sunder (1994). Experimental methods, a primer for economists. Cambridge.

Green, K. C. (2002). "Forecasting decisions in conflict situations: a comparison of game theory, role-playing, and unaided judgement." International Journal of Forecasting 18: 321-344.

Gurung, T. (2004). Use of Multi-Agent System to Improve Irrigation Water Sharing in Lingmuteychu Watershed, Bhutan. Chang Mai, Chang Mai Univerity: 163.

Hare, M., N. Gilbert, *et al.* (2001). The development of an internet forum for long-term participatory group learning about problems and solutions to sustainable urban water supply management. Zürich, Online Mediation Workshop, ETH: 8.

Hämäläinen, R., E. Kettunen, *et al.* (2001). "Evaluating a Framework for Multi-Stakeholders Decision Support in Water Resources Management." Group Decision Negotiation 10: 331-353.

Hermans, L. and P. Bots (2002). Metagames: exploring participatory stakeholder analysis for water management in Egypt. The W4S game: exploring the future consequences of water management. I. Mayer and W. Veeneman. Delft / The Hague, Eburon Academic Publishers: 205-223.

Huizinga, J. (1951). Homo Ludens: essai sur la fonction sociale du jeu. Paris.

Janssen, M., H. Goosen, *et al.* (2005). "A simple mediation and negotiation support tool for water management in the Netherlands." Landscape and Urban Planing [online] in press.

Jehng-Jung, K. and C. Ying-Jie (1996). "An educational water quality management game." Water Science and Technology 34(12): 205-211.

Kenyon, A. and R. Carter (1986). The Juba sugar estate game. Workshop on Simulation Exercises for Post-Experience training of irrigation managers, Wye College.

Kos, Z. and E. Prenosilova (1999). "Simulation and Gaming in Water Management in the Czech Republic." Simulation & Gaming 30(4): 476-481.

Lankford, B. A. and C. Sokile (2003). Reflections on the river basin game: Role-playing facilitation of surface water allocation in contested environments. ICID European Regional Conference "Consensus to resolve irrigation and water use conflicts in the Euromediterranean Region", Montpellier, France.

Le Bars, M., P. Le Grusse, *et al.* (2004). NECC: un jeu de simulation pour l'aide à la décision collective. Application à une région méditerranéenne "virtuelle". Acte du Séminaire Modernisation de l'Agriculture Irriguée, Rabat.

Leeuwis, C. (2004). Communication for rural innovation. Rethinking agricultural extension, Blackwell publishing company.

Lenselink, K. J. and M. Jurriëns (1993). Irrigation Games. Inventory of Irrigation Software for Microcomputers. Wageningen, ILRI: 15-24.

Maurel, P. (2003). Public participation and the european water framework directive. Role of Information and Communication Tools. WorkPackage 3 report of the HarmoniCOP project - Harmonising COllaborative Planning. Montpellier, Cemagref.

Mayer, I. and M. De Jong (2004). "Combining GDSS and Gaming for Decision Support." Group Decision and Negotiation 13: 223-241.

McDonald (1987). The Sukkur barrage game. Cambridge, UK.

McGrenere, J. (1996). Educational Multi-Player Games A Literature Review. Vancouver, Canada, University of British Columbia.

Moreno, J.-L. (1970). Les fondements de la sociométrie. Paris.

Mucchielli, A. (1983). Les Jeux de Rôles. Paris.

Parrish, J. (1982). Irrigation simulation game development. Logan, Utha, USA, Dept. of Agricultural and Irrigation Engineering, Utah State University.

Perez, P., A. Dray, *et al.* (2003). AtollScape: Simulating Freshwater Management in Pacific atolls, Spatial processes and time dependence issues. the International Congress on Modelling and Simulation, Townsville, Australia.

Schellings, T. C. (1961). "Experimental games and bargaining theory." World politics 14(1): 47-68.

Smith, L. E. D. (1989). "The Wye College Irrigation Game "Stop the breach"." Irrigation & Drainage Systems 3: 255-264.

Steenhuis, T., R. Oaks, *et al.* (1989). "Irrigation Rehab: A computer aided learning tool for system rehabilitation." Irrigation & Drainage Systems 3: 241-253.

Stooner, R. F., J. I. M. Dempster, *et al.* (1989). The use of simulation models in the management of irrigation systems. Irrigation - theory and practice. J. R. Rydzewski and C. F. Ward. London, UK, Pentech Press: 901-910.

Toth, F. (1988). "Policy Exercises." Simulation & Gaming 19(3): 235-255.

Tsuchyia, S. (1998). "Simulation/Gaming as an Essential Enabler of Organizational Change." Simulation & Gaming 29(4): 400-408.

Van Passen, A. (2004). Bridging the gap: computer model enhanced learning about natural resource management in Burkina Faso, Wageningen university and research center.

Weber, J. and D. Bailly (1993). "Prévoir c'est gouverner." Natures Sciences Sociétés 1(1): 59-64.

Annexe I.

30 RPGs dealing with water management found in the literature

GAME NAME	AUTHORS	DATE	were the game was played	type of environment	ISSUE	PURPOSE	OUTCOME	nb of played sessions	nb of players	types of players	Coupled with a model?
River Wadu Irrigation Project Planning Exercise	I. D. Carruthers	1981	UK	virtual	Difficulty of planning an irrigation scheme without revealing conflicting goals	to give students experience with a wide range of the practical problems arising in irrigation project planning	good teaching tool	used since 10 years	16 to 20	students	no
Rehab 1 et 2	T. Steenhuis, R. Oaks, R. Johnson, R. Sikkens, E. Velde	1981 - 1989	Sri Lanka other countries	virtual	difficulty of coordination between engineers, sociologists and planners in the rehabilitation of an irrigated perimeter	to create a non-conflicting environment to work on rehabilitation plans of an hypothetical irrigation system	sensitizes with the interrelationships of a system, helps to measure the priorities, encourages the debate of idea		interdisciplinary group or individual	stakeholders or students	Rehab 1 no, Rehab 2 yes
IRRIGAME	J. Parrish	1982	USA	virtual		irrigated crop management game in which the user is requested to make wide range of choices on parameters like advisory services, rainfall, crop type, soils, agronomic practices and irrigation method					
Sukkar Barrage	M. McDonald *et al.,* in Smith 1986)	1986	Pakistan	contextual		exercise intended for the operators of a dam in order to better management of the water flow				operators	yes
Juba Sugar Estate Game	A. Kenyon, R. Carter in Smith 1986)	1986	Somalia	contextual	scarce resources and inputs in the sugar estate context	to provide insight into the complex interactions between resources, inputs, activities and management decisions, to improve team work and to understand the complementary between job functions	more useful for the managers than for the irrigation engineers		3 to 20	students	no, a computer is used for important calculation
The Wye College Irrigation Game "Stop the breach"	L. Smith, J. Youngman	1989	India, Sri Lanka, the UK	generic virtual game that can be adapted to local contexts	the irrigation management is very complex and involves various types of stakeholders	to illustrate how works a water distribution system and the requests that it receives, and to give an experience on the complexity of water management solutions	best solutions on paper are not always adapted in a risk situation, shows the importance to be interdisciplinary			seniors and students	yes

Irrigation Management Game	M.A. Burton	1989	Indonesia, the U.K., Australia, Niger, Swaziland, India…	virtual	difficulty of coordination between the stakeholders (Irrigation Department staff and farmers)	to show the impact of the actions of the Irrigation Department staff on the farmers and their incomes	stimulating frank discussions, identifying common problems and solutions, and forming a group feeling among participants		10 to 20	students, irrigation engineers and scheme managers	no
NILE	R.F. Stoner, J.I.M. Dempster, S.L. Marsden	1989	Egypt	contextual		to give the practising engineers a feel for the volume of water involved in the Nile basin management	teaching tool on management choices			engineers	yes
Mahakali	M. McDonald	1989	Nepal	contextual	irrigation	training tool for planning and insight in operation of a set of engineering works				operators	yes
Great Lake Policy Exercise: the Ecosystem Philosophy Game	A.I. Frank, R.D. Duke	1995	USA	virtual	chemical and biological pollution of the Great Lakes	to improve the communication between stakeholders through the creation of a meta-model, to create a interdisciplinary for a global approach	allowed to share points of view, creation of an information and partnerships network	1	21	stakeholders	theoretical model "The Schematic"
educational game for water quality management	J.J. Kao, Y.J. Chen	1996		virtual		to assist a novice engineer or student to learn the compromises among three major objectives to manage water quality: cost, water quality, and equity				novice engineer or student	
WATER	Z. Kos, E. Prenosilova	1997	Czech Republic		conflict between water power generation, environment conservation, flood regulation…	training in decision making in conflict situations in management of multipurpose water reservoir	forces student to use a variety of approaches to decision making			students	yes
Njoobaari ilnoowo	O. Barreteau, F. Bousquet, J.-M. Attonaty	1998	Senegal	abstract	viability of the irrigated systems in the valley, fights of control	to better understand the articulation between usual and modern system of management of the irrigated space and to work on the coordination modes between the farmers of an irrigated system	has started a discussion and negotiation process on the sharing and the distribution of water, has improved the understanding of the social relations between individuals	7	12	Stakeholders, students	yes, SHADOC
Self Cormas	P. D'Aquino, C. Le Page, F. Bousquet, A. Bah	1998	Senegal	contextual	support to a policy of decentralization, conflicts on land use	to arrive at a sustainable management of the land taking of to account the various stakeholders	improvement in the local dialogue, new collective rules for the access to water	3	25	stakeholders	yes, simultaneous design with RPG

MEDTER	M. Le Bars, P. Gusse, M. Allaya, J.M. Attonaty, R. Mahjoubi	2001	France	abstract	to show the impacts of the individual decisions on the collective choices	to put the stakeholders in individual situation of choice of their crops, and show the impact of these choices in term of water consumption and on the various markets	training tool for the negotiation and support of test for new collective management rules	used for teaching since 5 years	variable	students	yes, OLYMPE
Lake Paijanne	R. Hamalainen, E. Kettunen, H. Ethamo	2002	Finland	contextual	the policy against the floods and for electricity generation has consequences on the environment	need for revaluing this policy in order to integrate more stakeholders (fishing, environmentalists etc.)		2	2 to ?	students	yes + an Internet version Joint Profits Decision Support System
Water for Space (W4S) game	L. Carton, S. Karsten	2001	Netherlands	virtual	space management without real taking in consideration of water	to explore the consequences of new ways of water management: to learn about the potentialities of water in term of spatial issues and to improve the dialogue between water managers and planners of space	discussions about the future development of the water management, has stimulated the dialogue. Designing the game was more interesting than playing the game		4 to 10	stakeholders	no
National Water Ressource Plan Metagame	L. Hermans, P. Bots	2001	Egypt	contextual	97% of the population live on 4% of the territory, problem of pollution of the Nile and future problems of water supply	to make a participative analyze of stakeholders involved in water management in Egypt, to make a diagnosis and to familiarize stakeholders with the participative tools	allowed to identify the stakeholders and better understand their opinions			stakeholders	theoretical model "metagame"
FIRMA water game	M. Hare, N. Gilbert, D. Medugno, T. Asakawa, J. Heeb, C. Pahl-Wostl	2001	Switzerland	contextual	contradictory water management objectives: to maintain the supply security and quality and at the same time to save water and money	to explore more efficient water management strategies in response to possible demand scenarios, to improve communication and the sharing of perspective among the various stakeholders	falls under the long term			stakeholders	yes, and the game continues on an Internet platform
RIPARWIN river bassin game	B. Lankford, C. Sokile	2003	Tanzania	abstract	increase of the demand, competition and sharing conflict	teaching tool to help users to share the resource, to make them understand their interdependence and to discuss possible improvements to water management efficiency	good tool for training and support of discussion, proposals for new modes of sharing and technical improvements	1	35	farmers, other water users, high-level support agencies, students, scientists	yes, a physical model is used
Dompola	T. Gurung, F. Bousquet, G. Trebuil	2004	Bhutan	contextual	inter-village conflict regarding water irrigation sharing	to improve dialogue between the two villages for a common management of the hydric resources	has created an non-conflicting environment, has improved communication among stakeholders, has improved common knowledge	2	12	stakeholders	No, a model has been developed subsequently

Atollgame	A. Dray, P. Perez, P. D'Aquino	2004	Tarawa Atoll	contextual	overpopulated atoll scarcity of water	to restore a climate of dialogue, to clarify the problem and to generate collective proposals for water management		1 then political locking		stakeholders	yes
SosteniCAP projet negowat	N. Faysse, Ampuero, R., Quiroz, F.	2005	Bolivia	contextual	internal management of community-based drinking water committee	to capacitate members of the committee, about the management of the committee and the management problems, and to support the search for solutions	capacitation, involvement in the whole intervention process	10	15	stakeholders	no
Larq'asninshej	Vega, D., Peñarrietta, R., Faysse, N.	2005	Bolivia	contextual	disturbance of the irrigation network by the anarchistic urbanization	to support the discussion and the dialogue between irrigants and urbans, to help them to have a non-local view of the issues	better knowledge, dialogue built between irrigation farmers and urban dwellers, involvement in the intervention process	10	15	stakeholders	no
Maehae Watershed	C. Barnaud, G. Trebuil, P. Promburom, F. Bousquet	2005	Thailand	contextual	extension and intensification of the cultures, shortage of water, some conflicts on the access	to clarify the use and the local management of water, to observe the decision-making process, to facilitate collective discussion	awakening of the problem, common reflexion and negotiation to identify solutions	1	12	stakeholders	yes
Just game	N. Ferrand, B. Nancarrow	2005	Australia	abstract	social justice on water rights	to improve comprehension of social justice and to encourage the emergence of new protocols of management	discussion between the small and the big farms	3		stakeholders and researchers	yes
Jogoman	D. Adamatti, J. Sicheman, C. Rabak, P. Bommel, R. Ducros, M. Camargo	2005	Brazil	contextual	multiplicity of the stakeholders having different kinds of representations and land uses	to improve the process of coordination and mediation for an integrated and decentralized resource management	better comprehension of the real phenomena	3	14	researchers and students and in future stakeholders	yes
PiePlue	O. Barreteau, G. Abrami, S. Chennit	2005	Drôme, France	abstract	lower ground water, overexploitation	to provide an interactive setting for future possible revision of a SAGE (Local Water Management Plan)		2 then political locking		scientists and managers	yes
Kat Aware	**S. Farolfi K. Rowntree**	2005	South Africa	contextual	reform in the water management, new governance structures with multiple objectives, need for negotiation	to facilitate negotiation among users, to better understand their strategies	Stakeholders are more keen to discuss and negotiate strategies for water allocation and management at the local level.	1	4 t0 8	Stakeholders (Kat River Water User Association)	yes, AWARE
RIVERMED	CME pour le CPIE des Pays du Vaucluse	?	France	virtual	floods	educational: to show the complexity of the problem, to present land settlement, to present the effects of the flood	to sensitize with the concept of risk		12 to 18	childrens	No